REMARKS

The Applicants appreciate the quick and courteous Office Action.

Claims 1-17 and 19-28 are pending in the application. Claims 1-28 stand rejected. Claims 1, 16 and 25 are amended. Claim 18 is canceled. No new matter is added. Applicant respectfully requests reconsideration in view of the amendment and further in view of the following remarks.

Rejection Under 35 U.S.C. §103 over Kalnins in View of Malina

The Examiner has rejected claims 1, 10-12, 25, 27, 28 under 35 U.S.C. §103(a) as allegedly being unpatentable over U.S. Pat. No. 5,110,471 to Kalnins in view of U.S. Pat. No. 3,988,239 Malina for reasons of obviousness.

The Examiner finds that Kalnins teaches a hydrocyclone comprising a head section 22, having a fluid inlet 20, an overflow outlet 18, and a separation section 26 having an underflow outlet 16. The Examiner admits that Kalnins does not teach that the liner comprises two materials, a first material in the head section with a first resistance to erosion and a second material in the separation section having a second resistance to erosion, where the first resistance to erosion is generally greater than the second resistance to erosion. The Examiner notes that Kalnins does disclose that recirculation in the head section causes erosion of the outer wall of the head section.

The Examiner additionally finds that Malina teaches a hydrocyclone liner comprising two materials 44 and 46, wherein the material 46 has a higher resistance to erosion than material 44. Malina is further seen to teach that the wear resistant materials comprise tungsten carbide, silicon carbide, ceramic and metal, which includes stainless steel. He is further seen to teach that a separation section liner can be made out of a relatively soft, more flexible material that would be resistant to bending and impacts. The Examiner thus contends that it would have been obvious to one of ordinary skill in the art to include the liner of Malina comprising the two materials in the hydrocyclone of Kalnins to protect the walls of the hydrocyclone, wherein the highly wear resistant material is placed in the head section to prevent erosion due to recirculation in the head section.

The Applicants respectfully traverse.

The Examiner's attention is respectfully directed to all of the independent claims where they have been amended to specify that the claimed hydrocyclone liner is a liquid/liquid hydrocyclone liner. Support for this change is found in the application as filed on page 7, line 10 of paragraph [0016]; page 9, line 22 to page 10, line 2 of paragraph [0033]; and elsewhere.

Liquid/liquid hydrocyclones, even if some solids are present in the liquids being separated, as contemplated here, are different from solid/liquid hydrocyclones. The Examiner's attention is respectfully directed to paragraphs [0004] to [0007] of the application as originally filed:

> **[0004]** Hydrocyclone liners are used both for the separation of liquids from solids in a liquid/solid mixture ("liquid/solid hydrocyclones") as well as for the separation of liquids from other liquids ("liquid/liquid hydrocyclones"). *Different constructions are used for each of these hydrocyclone devices.* The liquid/liquid type of hydrocyclone liner is longer in the axial direction than a solid/liquid hydrocyclone liner and is thinner as well. As a result of these structural differences, the engineering of a liquid/liquid hydrocyclone liner that is both erosion-resistant and which can support its own weight is challenging.
>
> **[0005]** *It is noted that erosion resistance has heretofore not been considered as important a design consideration for liquid/liquid hydrocyclone liners as for liquid/solid hydrocyclone liners, since liquid/solid hydrocyclones have been expected to experience greater wear due to the large amount of solids present in the material being separated.* Liquid/liquid hydrocyclones, by contrast, are considered to have no or very little solids content and, therefore, erosion is less of a concern. Conventionally, then, liquid/liquid hydrocyclone liners have been designed for optimal corrosion resistance, assuming either no or very little erosion, and then later discarded or repaired in the event of erosion damage to the liners. *In fact, however, erosion of liquid/liquid hydrocyclones is a serious problem in certain installations.* Impurities in the form of solid particles are suspended in the liquids to be separated. The inventors have recognized that these solid particles are capable of causing tremendous erosion of the hydrocyclone liner, particularly upon those portions of the liner that experience high rotational fluid forces. Thus, an improved erosion-resistant liquid/liquid hydrocyclone liner would be desirable.
>
> **[0006]** Normally, hydrocyclone liners for separating fluids are made from one or more homogeneous materials. When increased resistance to erosion is required (due to entrained solids in the fluids), the current practice is to simply substitute the original material of the liner for an erosion-resistant material, such as alumina ceramic or tungsten car-

bide. If the diameter of the hydrocyclone liner is large enough, such as for solid-liquid separating liners, it may be possible to spray an erosion-resistant coating into the bore of the liner. Repeated spraying of such coating allows a longer life for the liner. *This is not generally an available option for narrow bore liquid/liquid liners, such as is used in petroleum fluid processing.* Access to the interior surfaces of the liner is limited due to the small diameter (typically less than 2") of portions of the liner, and the length of the liner makes an even and complete coating unlikely. Further, only a limited number of suitable coating treatments are known that will harden the steel of the liner against erosion without compromising its corrosion resistant properties.

[0007] Erosion-resistant materials, such as ceramics or certain alloys, may be very heavy or brittle, such that the construction of the entire liner from such erosion-resistant material is not desirable. For example, tungsten carbide, a common erosion-resistant material, is twice as dense as steel. A hydrocyclone liner comprised entirely of an erosion-resistant material, such as tungsten carbide, might not be fit for service due to poor mechanical properties (including weight and tensile strength) and high cost. *Liquid/liquid hydrocyclone liners are typically installed horizontally, being supported by a support plate at either end.* Depending on the mode of installation, the liners may be left cantilevered from one support plate, with the liner having to take the weight of the head casting, while the second support plate is moved into position. Also, installation may require that a liner be physically hammered into place in the first support plate. *During installation, then, a heavy and brittle liner might easily be damaged.* As petroleum fluid processing is often located in shipboard installations or on off-shore platforms, a highly reliable and relatively lightweight hydrocyclone liner is desired. (Emphasis added.)

The Applicants respectfully submit that Malina is inappropriately cited against the claims herein since it relates to solid/liquid cyclones and does not and cannot teach appropriately for liquid/liquid hydrocyclones as claimed. The Examiner's attention is respectfully directed to column 1, lines 31-40 of Malina.

For many years the response to erosion in oil/water hydrocyclones was to declare them to be disposable items. Financial pressures on end users have led them to demand a solution.

The challenge with oil-water hydrocyclones is that 1) they are long and 2) they are narrow in cross section. This makes internal linings and coatings difficult or impossible to implement without having a negative impact on the separation performance of the hydrocyclone (which basically depends on the ratio of the diameter to the length).

Surface treatments including case hardening do not have a serious effect on internal diameter, but the length of the cyclone rules out a number of techniques. Breaking the cyclone into small length sections for treatment is problematic as the joints cause turbulence which promotes erosion and can reduce oil/water separation efficiency.

The use of hard materials is difficult because a long, thin object is difficult to make in such materials. The hydrocyclone also cannot support its own weight if constructed of these materials, and is sensitive to shock loading.

Further, while a process might use one to a dozen solid/liquid cyclones, to treat the same flow with liquid/liquid cyclones requires hundreds of hydrocyclones. Arrangements such as those shown by Malina would be commercial infeasible, partly due to the engineering problems and partly due tot the fact that whilst the internal diameter of the hydrocyclone would have to stay the same, the outer diameter would need to be increased. If hundreds of these hydrocyclones were packed into a vessel, the vessel would become prohibitively large.

While the Applicants stipulate that Malina relates to a hydrocyclone where there is a greater wear portion and a lesser wear portion, it is respectfully noted that the positioning of these materials is *backwards* or *reversed* from that of invention claimed herein. For instance, please note FIGS. 1 and 2 of Malina and column 5, lines 24-27 where insert **46** is made of a highly wear resistant material while bladder **44** is a material having lesser wear resistant characteristics than insert **46**, and note that insert **46** is positioned much closer to second outlet **18** than the relatively larger portion of bladder **44** which is positioned analogously to the involute of the claimed hydrocyclone. Thus, Malina in fact *teaches away from* the invention by inverting or reversing the relative positions of the material having the greater resistance to erosion.

An obviousness rejection cannot stand if the references teach away from the invention, *In re Hedges* 228 U.S.P.Q. 685,687, 837 F.2d 473 (Fed. Cir. 1986).

A reference which leads one of ordinary skill in the art away from the claimed invention cannot render it unpatentably obvious. *Dow Chemical Co. v. American Cyanamid Co.* 816 F.2d 617, 2 U.S.P.Q.2d 1350 (Fed. Cir. 1987); *In re*

Grasseli, et al., 713 F.2d 731, 218 U.S.P.Q. 269 (Fed. Cir. 1983); *In re Dow Chemical Co.* 837 F.2d 469, 5 U.S.P.Q.2d 1529 (Fed. Cir. 1988).

The Examiner's attention is further respectfully directed to *In re Haruna, et al.*, 249 F.3d 1327, 1335; 58 U.S.P.Q. 2d 1517 (Fed. Cir. 2001):

> "A prima facie case of obviousness can be rebutted if the applicant ... can show 'that the art in any material respect taught away' from the claimed invention." *In re Geisler,* 116 F.3d 1465, 1469, 43 U.S.P.Q.2d (BNA) 1362, 1365 (Fed. Cir. 1997) (quoting *In re Malagari,* 499 F.2d 1297, 1303, 182 U.S.P.Q. (BNA) 549, 533 (CCPA 1974)). "A reference may be said to teach away when a person of ordinary skill, upon reading the reference, ... would be led in a direction divergent from the path that was taken by the applicant." *Tec Air, Inc. v. Denso Mfg. Mich. Inc.*, 192 F.3d 1353, 1360, 52 U.S.P.Q.2d (BNA) 1294, 1298 (Fed. Cir. 1999).

Here, Malina teaches that insert **46** is made of a highly wear resistant material while bladder **44** is a material having lesser wear resistant characteristics than insert **46** (column 5, lines 24-27). These relative positions are reverse of what is claimed. It is respectfully submitted that the reference thus teaches away from the claimed configuration in a material respect. There is nothing in Malina or Kalnins that teaches or suggests the relative positions of these materials should be reversed. As noted, claim 1 herein (and claims dependent thereon) have a head section formed "primarily of a first material having a first resistance to erosion" and a "separation section being formed primarily of a second material having a second resistance to erosion" where "the first resistance to erosion is generally greater than the second resistance to erosion", which is different from and not suggested by the references alone or in combination.

The Applicants respectfully submit that it is not obvious to place the highly wear resistant material in the head section to prevent erosion there. There is nothing in Malina or the Kalnins that teaches or suggests reversing the positions of the materials of Malina which clearly and consistently only teaches the design shown and described. At most, one *having* ordinary skill in the art with the references before them would make the entire Kalnins hydrocyclone of the Malina

greater wear material to address the erosion of the head section therein, but such a structure is *not* the claimed invention.

With respect to claim 25 and claims dependent thereon, claim 25 has been amended herein to recite a similar distinction to that discussed above. Support for the amendment to claim 25 is found in claims 1 and 18 of the application as filed and elsewhere.

Reconsideration is respectfully requested.

Rejection Under 35 U.S.C. §103 over Kalnins in View of Malina and Ellyin, et al.

The Examiner has rejected claims 3-6 under 35 U.S.C. §103(a) as allegedly being unpatentable over Kalnins in view of Malina in view of U.S. Pat. No. 6,354,334 to Ellyin, et al. for reasons of obviousness.

The Examiner admits that neither Kalnins nor Malina teach a reinforcement layer disposed upon the separation section, but contends that Ellyin, et al. teaches such a layer. Ellyin, et al. is found by the Examiner to teach a steel liner wrapped with a stack of sheets of glass fiber-reinforced epoxy. It is also seen to teach that the fibers can be carbon fibers as well. The fibers are found to be disposed axially within the epoxy to provide resistance to bending.

The Examiner contends that it would have been obvious to one of ordinary skill in the art to wrap the hydrocyclone of Kalnins in the reinforcement layer of Ellyin, et al. in order to strengthen the thin separation section so that the tubular length does not bend or warp while the hydrocyclone is in a cantilevered position during installation.

The Applicants must again respectfully traverse.

Ellyin, et al. relates to a steel liner of a pipe or vessel wrapped with a stack of sheets of glass fiber-reinforced epoxy matrix composite arranged in angle-ply pattern. The stack is cured on the liner to bond the sheets together and to the liner. The wrapped liner is then internally pressurized to cause the liner to yield while the composite remains elastic. When de-pressurized, the liner has compressive residual stress and the composite has tensile residual stress. (Abstract) In

short, Ellyin, et al. concerns expanding the operating envelope of a pressurized pipe, not a hydrocyclone.

In contrast, a hydrocyclone is open at both ends and is not pressurized (although it incurs a relatively small pressure drop across itself during operation). In the claims at issue, the purpose of the reinforcement layer is to make the use of the hard, brittle erosion resistant material feasible. The inventors herein attempted to make a hydrocyclone with silicon carbide tail pipes and a tungsten carbide head – It shattered in transport! When the separation section is carbon fiber wrapped (*e.g.*, as recited in claim 5), the silicon carbide does still break, but the silicon carbide is contained and held within the composite sleeve. The internal surface finish is not compromised. This is not taught or hinted at by Ellyin, et al., it is respectfully submitted.

Furthermore, it is respectfully submitted that there are no teachings, hints or suggestions in Ellyin, et al. that supply the deficiency established above with respect to the previous rejection. That is, Ellyin, et al. does not supply any motivation for a hydrocyclone where the head section has "an involute formed primarily of a first material having a first resistance to erosion", a "separation section being formed primarily of a second material having a second resistance to erosion" where "the first resistance to erosion is generally greater than the second resistance to erosion" rather than the opposite configuration taught by Malina – which in fact teaches away from the invention. "When patentability turns on the question of obviousness, the search for and analysis of the prior art includes evidence relevant to the finding of whether there is a teaching, motivation, or suggestion to select and combine the references relied on as evidence of obviousness." *In re Lee,* 277 F.3d 1338, 1343, 61 U.S.P.Q.2d 1430 (Fed. Cir. 2002). It is respectfully submitted that such motivation is absent here, and even if the references were combined, the structure recited in the instant claims would not result because the relative position of the material having the generally greater resistance to erosion is not taught or suggested by the references. As established *supra*, at most one having ordinary skill in the art would make the entire Kalnins hydrocyclone of the Malina greater wear material, which is *not* what is claimed.

It is respectfully submitted that the subject claims are not obvious from the combined references and that the claims are allowable thereover. Reconsideration is respectfully requested.

Rejection Under 35 U.S.C. §103 over Kalnins in View of Malina and Hakola

The Examiner has rejected claims 2, 9, 16-22, 24, and 26 under 35 U.S.C. §103(a) as allegedly being unpatentable over Kalnins in view of Malina as applied to claims 1 and 25 above, and further in view of U.S. Pat. No. 4,541,934 to Hakola for reasons of obviousness.

The Examiner admits that neither Kalnins nor Malina teach that the head section and separation section are removably affixed to one another by a flange assembly, but finds that Hakola does. The Examiner additionally notes that Fig. 1 of Hakola teaches that the separation section comprises tubular portions that are interconnected by a tubular joint member.

The Examiner contends that it would have been obvious to one of ordinary skill in the art at the time the invention was made to combine the separable head and separations feature of Hakola with the hydrocyclone liner of Kalnins if one desired to be able to gain access to the sections in order to replace the liners when worn out so that one could save money by not having to replace the entire hydrocyclone apparatus.

Again, the Applicants respectfully traverse.

The Applicants stipulate that Hakola describes a split hydrocyclone, but this is to allow a worn part to be replaced quickly, rather than to tailor different materials to the expected modes of failure, *e.g.* high angle particle impingement in the head section vs. the low angle, almost "sliding" wear experienced by the tail section. That is, Hakola does not teach or suggest what is lacking in the combination of the Kalnins and Malina references – that the first material of generally greater resistance to erosion is found in the involute, whereas the second material of relatively less resistance to erosion is found in the separation section. This configuration is taught away from by Malina, and there is nothing in Hakola to teach the structure recited in the claims at issue. Further, Hakola relates to solid/liquid

cyclones (column 1, lines 42-47), rather than the claimed liquid/liquid hydrocyclones.

It is further noted that independent claim 16 has been amended herein to recite the language of original dependent claim 18 that highlights this distinction, and thus this amendment does not constitute an improper insertion of new matter (claim 18 has been cancelled as redundant).

It may be noted that breaking a hydrocyclone into small length sections for treatment is problematic as the joints cause turbulence which promotes erosion and can reduce oil/water separation efficiency. Indeed, Hakola explicitly teaches the more conventional approach of simply throwing away the liner when it is sufficiently worn out (please see column 8, lines 17-19). For many years the response to erosion in oil/water hydrocyclones was to declare them to be disposable items. Finally, financial pressures on end users have led to a need for more durable hydrocyclones such as those recited in the instant claims.

For these reasons, it is respectfully submitted that the claims as presently recited are not obvious over the instant combination of references. Reconsideration is respectfully requested.

Rejection Under 35 U.S.C. §103 over Kalnins in View of Malina and Gil et al.

The Examiner has rejected claims 13 and 14 under 35 U.S.C. §103(a) as allegedly being unpatentable over Kalnins in view of Malina as applied to claim 1 above, and further in view of U.S. Pat. Appln. Publication 2001/00020009 to Gil et al. for reasons of obviousness.

The Examiner finds that Malina teaches that the liner can be made from metal, however, the Examiner admits that Malina does not teach that the liner is made from stainless steel, but finds that Gil et al. teach this. The Examiner contends that it would have been obvious to one of ordinary skill in the art to construct the hydrocyclone liner of Malina from stainless steel as taught by Gil et al. as stainless steel is known to have very good resistance to both corrosion and erosion. In addition, although not specifically stated it is well known in the art that case hardening is a common way of manufacturing and treating stainless steel in order to make it as corrosive and erosive resistant as possible.

Once more the Applicants respectfully traverse. Gil et al. relates to solid-liquid separation applications (please see at least the Abstract and claims therein) rather than liquid/liquid hydrocyclones and does mention that hydrocyclones may be made of stainless steel. However, Gil et al. again does not teach the deficiency or gap in the combined teachings of Kalnins with Malina to get to the invention as claimed herein. That is, none of the three references individually or collectively hint or suggest that the involute is formed primarily of a first material having a first resistance to erosion; the separation section is formed primarily of a second material having a second resistance to erosion; and the first resistance to erosion is generally greater than the second resistance to erosion. Of these references, only Malina addresses different materials – and it *teaches away from* the invention as claimed and does not teach anything with respect to liquid/liquid hydrocyclones. For this reason, it is respectfully submitted that a *prima facie* rejection of claims 13 and 14 has not been made. Reconsideration is respectfully requested.

Rejection Under 35 U.S.C. §103 over Kalnins in View of Malina, Hakola and Ellyin, et al.

The Examiner has rejected claim 23 under 35 U.S.C. §103(a) as allegedly being unpatentable over Kalnins in view of Malina in view of Hakola as applied to claims 16 and 17 above, and further in view of Ellyin et al.

The Examiner notes that Hakola does teach an external support structure for the separation section, wherein the structure is a sleeve 68. However, the Examiner admits that Hakola does not teach that the structure is a fiber-reinforced epoxy sleeve as Ellyin, et al. does. The Examiner contends that it would have been obvious to one of ordinary skill in the art at the time the invention was made to construct the sleeve of Hakola from the fiber-reinforced epoxy of Ellyin, et al. if one desired to be able to take advantage of the high strength to light weight ratio of the fiber-reinforced material in order to make the structure lighter and easier to handle.

The Applicants must respectfully traverse once more. The Applicants respectfully submit that even this combination of four references because between all four references there is no hint, suggestion or teaching of a hydrocyclone as recited in the instant claims with the relative erosion resistant materials in their respective positions as repeatedly discussed and established. Additionally, the claimed invention now recites liquid/liquid hydrocyclones and the teachings of both Malina and Hakola only relate to solid/liquid separators, whereas Ellyin et al. concerns neither and only relates to pressurized vessels or pipes. For this reason alone, a *prima facie* obviousness rejection has not been established, and reconsideration is respectfully requested.

Rejection Under 35 U.S.C. § 103 over Kalnins in View of Malina and Applicants' Disclosure

The Examiner has rejected claims 3, 8, 14, and 15 under 35 U.S.C. §103(a) as allegedly being unpatentable over to Kalnins in view of Malina as applied to claim 1 above, and further in view of Applicants' disclosure.

The Examiner admits that Kalnins and Malina are silent to a reinforcement layer sprayed upon the separation section, but contends that the Applicants' own application discloses such a practice as being known in the prior art, referring to page 12+.

The Examiner contends that it would have been obvious to spray a reinforcement layer upon the separation section as disclosed by the Applicants if one desired to be able to reinforce the material and help ensure a longer life of the separation section, and further that it would have been obvious to one of ordinary skill in the art to spray a coating on the steel liner to harden the liner against erosion and help ensure a longer life of the liner.

The Applicants must respectfully traverse yet again.

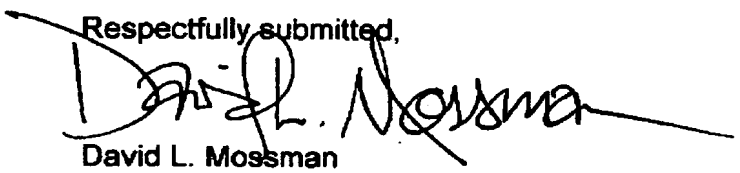
First, the Applicants are confused about why claims 3, 14 and 15 are part of this rejection since they do not concern or recite spraying.

Additionally, as previously established, the recited configuration of the first and second materials of relative resistance to erosion recited in independent claim

1 upon which these claims depend is not taught or suggested by the combination of Kalnins and Malina as previously established. The Examiner's attention is respectfully directed to the previous discussions (especially that related to the first rejection), which will not be repeated here for the sake of brevity. For this additional, separate reason alone, a *prima facie* obviousness rejection has not been made. Reconsideration is respectfully requested.

It is respectfully submitted that the amendments and arguments presented above place the amended claims in condition for allowance. Reconsideration and allowance of the claims, as amended, are respectfully requested. The Examiner is respectfully reminded of her continuing duty to indicate allowable subject matter. The Examiner is invited to call the Applicants' attorney at the number below for any reason, especially any reason that may help advance the prosecution.

Respectfully submitted,



David L. Mossman
Registration No. 29,570
Attorney for Applicants
Telephone No. 512/219-4026
Facsimile No. 512/219-4036

Madan, Mossman & Sriram, P.C.
2603 Augusta, Suite 700
Houston, TX 77057-5638